Successions of Microbioeroding Communities over a Year Period with a Monthly Resolution : Impact on Biogenic Dissolution in Dead Corals (New Caledonia)

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Introduction

Coral reefs maintenance results from the balance between constructive and destructive forces, those being mainly due to the agents of bioerosion. Microborers -cyanobacteria, microalgae and fungi- are the main agents of biogenic dissolution in dead substrates such as coral skeletons. However, very little is known on the early stages of their community successions and associated biogenic dissolution rates.

In this study we present

- The **early stages of community successions over a year period**
- When ***Ostreobium quekettii***, the main agent of carbonate dissolution **settles down** and **becomes the dominant species**
- The **dynamics of the biogenic dissolution** process with a monthly resolution and **the correlation with the microborer communities**

Material and Methods

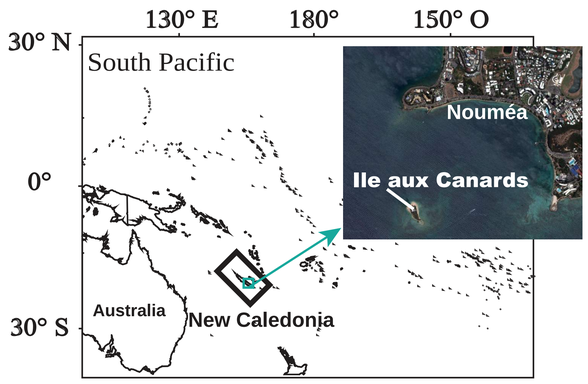

Figure 1: Map of the study site in New Caledonia.

An *in situ* high temporal resolution study is carried out in New Caledonia (Fig.1) since 2009. Experimental coral blocks (skeleton of *Porites sp.*) are regularly exposed to colonization by microborers.

60 Blocks were fixed on 2 grids at 3-m depth in December 2010 (summer season) for a year period (Fig.2). Each month, 5 blocks were sampled: 3 blocks for this study and 2 additional blocks for the study of the impact of microborers on the geochemical composition of coral skeletons (see Poster #2254 C.Brahmi et al.)

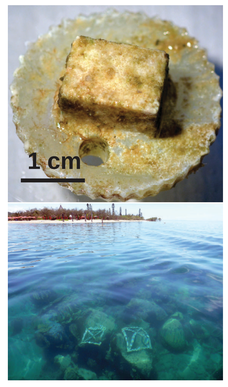

Figure 2: **A**-Coral block after 6 months of microbioersion; **B**-The 2 grids at 3-m depth

To characterize the biogenic dissolution per month due to microborers, 4 parameters were determined on blocks:

(1) Species composition of microboring communities,
(2) Succession of microborers,
(3) Filament depth of penetration in blocks
(4) the bioeroded surface area at the surface of blocks.

Here, biogenic dissolution is expressed in kg of $CaCO_3$ dissolved per square meter of coral reef and per unit of time.

All data were analysed using R software.

Community Composition

Observed microborers comprised (Fig.3):

-**3** species of **chlorophytes** (*Eugomontia* sp., *Phaeophila* sp., *Ostreobium quekettii* and unidentified species),

-**3** species of **cyanobacteria** (*Hyella* sp., *Mastigocoleus testarum, Plectonema terebrans*),

-**fungal filaments**

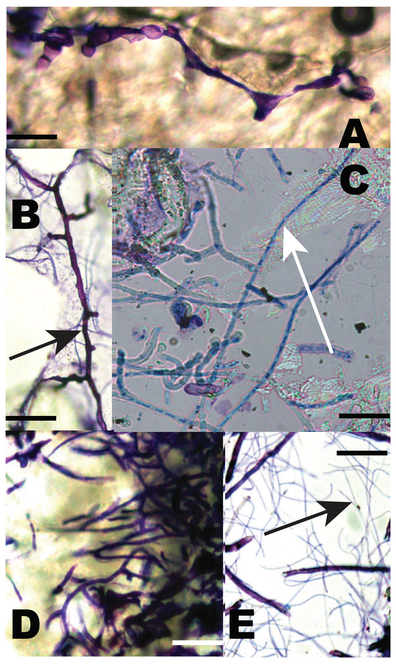

Figure 3: **A**- *Phaeophila* sp.; **B**- *Ostreobium quekettii*; **C**- *Hyella sp.*; **D**- *Mastigocoleus testarum;* **E**- Fungi or *Plectonema terebrans*. *Scale bar = 40µm*

Microborer Successions and Distribution

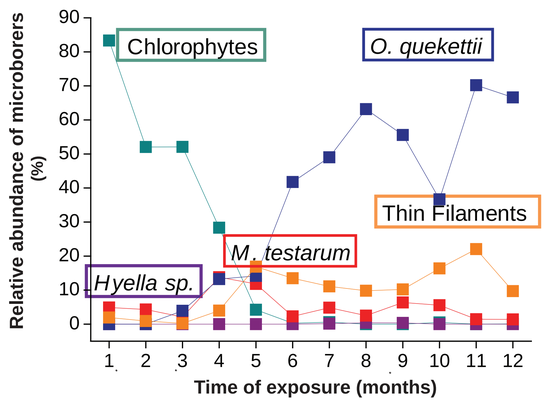

Figure 4: Relative abundance of microborers in pourcent according to the time of exposure in months.

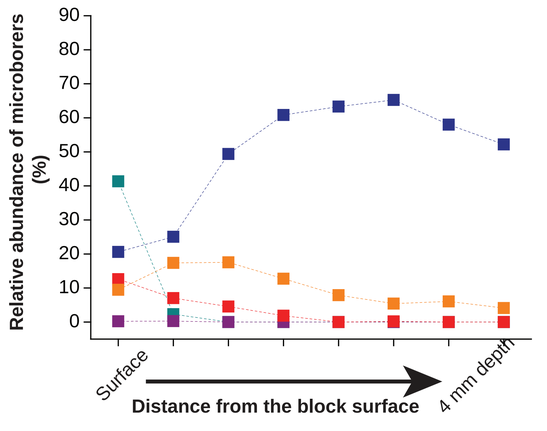

Figure 5: Relative abundance of microborers in pourcent according to the distance from the block surface. See legend in the Fig.4

-**Chlorophytes** other than *O. quekettii* are **dominant during the first 4 months** (Fig.4), characterizing immature communities.

-*M. testarum* and thin filaments (fungi and *P. terebrans*) are present through the duration of the experiment but are not abundants (<20%, Fig.4).

-***O. quekettii* start settling** on substrates **after 3 months** of exposure and **dominates after 6 months** (Fig.4), characterizing mature communities.

-**Chlorophytes** other than *O. quekettii* and **cyanobacteria penetrate no more than 2 mm** into substrates (Fig.5). Those organisms are known to request light (photophile species).

-***O. quekettii*** and **thin filaments** (mainly fungi) **penetrate up to 4mm** into substrates (Fig.5). *O. quekettii* is a sciaphile species, adapted to low light intensities.

Biogenic Dissolution by Microborers

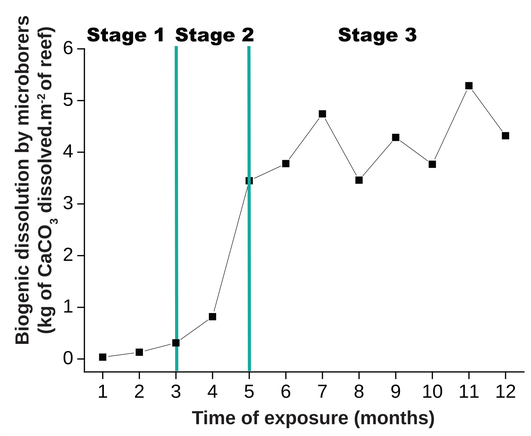

Figure 6: Biogenic dissolution by microborers expressed in kg of $CaCO_3$ dissolved per square meter of reef according to the time of exposure in months.

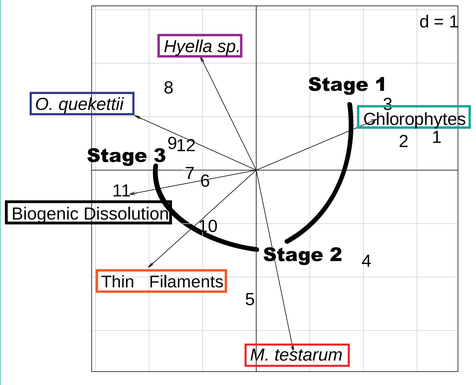

Figure 7: Principal Component Analysis

-After 12 months of colonization, 4.3 kg of $CaCO_3$ are dissolved per square meter of reef (gross dissolution rates, Fig.6).

-The **dynamic of biogenic dissolution** is **non-linear** (Fig.6) and seems to be strongly **correlated** with the successions of **microborer communities** (Fig.4, 6 and 7)

-The dynamic of biogenic dissolution **comprised 3 stages** (Fig.6 and 7):

Stage 1: Low dissolution rates
Settlement and **dominance of Chlorophytes** other than *O. quekettii* that remains at the surface (Fig.4 and 5).

Stage 2: High dissolution rates
Settlement of *O. quekettii* (Fig.4) that penetrate down to 4 mm (Fig.5). **Increase** of ***M. testarum*** **abundance** (Fig.4).

Stage 3: Stabilization of dissolution rates
O. quekettii **dominates** microborer communities (Fig.4) and **drives the biogenic dissolution process** (Fig.7).

Conclusions

This is the first study on the successions of microborer communities and the associated biogenic dissolution with a montly resolution *(Grange et al. in prep.)*.

Community successions

- The first 4 months, **Chlorophytes** other than *O. quekettii* are **dominants** but are beneath substrate surface. **After 6 months**, ***O. quekettii*** is the **most abundant** species and penetrates deeply into substrates (>4 mm).These results comfirm those of Gektidis (1999, *Bull. Geol. Soc.*) and Chazottes et al. (1995, *Palaeos3*).
- The new founding here is that after 3 months (still in summer), ***O. quekettii* is already settled** and is deep inside substrates (~1 mm).

The pattern of early biogenic dissolution of carbonates by microborers

- This **process evolves non-linearly nor proportionally over 12 months** confirming the hypothesis of Tribollet & Golubic (2005, *Coral Reefs*). **it's thus not recommanded to extrapolate biogenic dissolution obtained after a few days or months to a year.**

- 3 stages in this process are noticed over the 12 months period : (1) A slow increase between 0-3 months, (2) an exponential increase between 4 and 7 months, and then (3) a «plateau» after 7 months.

- Parameters such as **grazing and environmental conditions (T°C, S...) could explain the variability after 7months**.